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REGULAR ARTICLES

Prevalence, intensity and risk factors of infestation with major gastrointestinal nematodes in equines in and around Shashemane, Southern Ethiopia

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Abstract Prevalence, intensity and risk factors of major gastrointestinal nematode infestation in equines were studied through a cross-sectional survey in 384 equids from October 2013 to April 2014 in and around Shashemane, southern Ethiopia. Three hundred and fifteen equids (82 %) were demonstrated harbouring one or more gastrointestinal (GIT) nematodes using the faecal flotation technique. The prevalence of GIT nematode infestation was 73.4, 85 and 86.5 % for horses, mules and donkeys, respectively. The identified nematodes were strongyle type (73.4 %), *Parascaris equorum* (21.4 %) and *Oxyuris equi* (4.4 %). Species of equines had a significant (χ^2=9.35, P<0.01) association with the occurrence of GIT nematode infestation. Donkeys were two times (OR=2.3, 95 % CI 1.27–4.28, P<0.01) more likely getting GIT nematode infestation than horses. Moreover, donkeys had the highest mean faecal egg counts (1831.2 egg per gram (EPG)) followed by mules (915.7 EPG) and horses (772.5 EPG). There was a significant association (P<0.05) between mean EPG and body condition score in each equine species. In conclusion, this study provides information which might help in designing upcoming control strategies to control nematode infestation in equines. Moreover, suitable tropical climatic conditions, low level of management and owners' awareness, and poor animal health services are expected to contribute for high nematode infestation. Therefore, emphasis should be given to awareness creation about the strategic deworming, animal welfare and management.

Keywords Equine · Gastrointestinal nematode · Infestation · Intensity · Prevalence · Shashemane

Introduction

Estimates have shown that Ethiopia possesses about 9 million equines that represent half of the Africa's equine population (CSA, 2013). Equines have a prominent position in the Ethiopian agricultural economy and are used for different activities in rural and poor urban communities. They play a great role in transportation (riding, packing and cart pulling), farming (tillage and threshing), weeding and tourism, raising water and milling (Bersisa et al., 2012). Despite their great role in the sector of transportation and agricultural economy of the country, the health management accorded to equines has been far below than that given to other livestock species (Stringer et al., 2015). This could partly be due to the age-old perception and concept of communities that equines are hardy, tolerant and probably because they are not suppliers of meat and milk (Bersisa et al., 2012). Feed shortage, working stress and diseases (parasitic, bacterial, viral and nutritional origins) are the major factors that hamper the health status and performance of equines in Ethiopia (Dessie and Melese 2013).

Infestation with gastrointestinal parasites is one of the most common health concerns of equines in many agro-ecological zones (Burden et al., 2010) and a serious threat to the livestock economy worldwide (Valdéz-Cruz et al., 2013). The harmful effects of parasitism on equines can be manifested by diarrhoea; colic; reduced feed intake; emaciation; poor body condition and traction power; loss of blood, ions and plasma proteins into the gastrointestinal tract; protein metabolism

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alterations; and death of infested equines (Valdéz-Cruz et al., 2013; Flanagan et al., 2013). All these clinical effects result in serious economic losses to the farmers and the nation in general. Therefore, to improve the health status and welfare of equines and to formulate, implement and monitor an efficient and effective parasitic control strategy, undertaking a survey to understand the prevalence of gastrointestinal (GIT) parasites in various areas and associated factors that influence their transmission and burden is essential and a basic step.

Prevalence of GIT nematode infestations has been reported ranging from 22.9 to 100 % in equines from various parts of the world (Valdéz-Cruz et al., 2013; Dessie and Melese 2013). There are different factors influencing the prevalence of GIT nematode, including age, sex, species, climate and management practices (Nielsen et al., 2007). In Ethiopia, several attempts have been conducted on equine GIT nematode infestations from various regions reporting a prevalence range from 60.8 to 100 % (Fikru et al., 2005; Getachew et al., 2010; Dessie and Melese 2013). However, there is limited knowledge about the prevalence, level of infestation and risk factors of GIT nematodes in equines in southern Ethiopia. Information regarding the prevalence and intensity of GIT nematodes of equines is crucial for developing and monitoring strategic control measures in developing countries, like Ethiopia. Therefore, this study aimed (1) to identify the major gastrointestinal nematodes of equines in and around Shashemane, (2) to determine the prevalence and level of infestation of gastrointestinal nematodes, and (3) to assess the risk factors that influence the prevalence and intensity of nematode parasitism.

Materials and methods

Study area

The study was conducted in and around Shashemane, southern Ethiopia, about 240 km from the capital city, Addis Abeba. Shashemane is located at a latitude of 7° 12′ N and a longitude of 38° 36′ E. The altitude of the study area ranges from 500 to 1700 m.a.s.l.. The area has a bimodal type of rainfall and receives an average annual rainfall ranging from 800 to 1400 mm. The soil type of the area is mainly clay and sandy loam. Mixed farming system has been practiced by the communities in the study area (WAZoARD, 2009).

Study design and sample size

A cross-sectional study type was employed to determine the prevalence, level of infestation and associated factors of major gastrointestinal nematodes of equines. Simple random sampling using lottery technique was used to select the study animals. The sample size of the present study was determined by using a single population proportion formula given by Thrusfield (2007). Since, there has been no previous report to the area, the required sample size was determined based on expected prevalence of 50 and 5 % absolute precision at 95 % confidence interval. Accordingly, 384 animals were selected for the present study.

Study animals

A total of 124 horses, 200 donkeys and 60 mules were drawn from all ages and both sex groups of equine population. They are local breeds in origin and are mainly kept for cart pulling and packing purpose under extensive management system. The age of the sampled equines was estimated based on the technique given by Loch and Bradley (2000). Accordingly, the sampled equines were grouped as young (<3 years), adult (3–10 years) and old (>10 years). The animals were also categorised into good, medium and poor body condition score as given by Svendsen (1997).

Sample collection

Faecal samples were collected directly from the rectum or from the ground when the animal was seen defecating immediately with strict sanitation. The samples were placed in air- and water-tight sample vials, labelled, refrigerated and then transported to the Hawassa University, School of Veterinary Medicine, Parasitology Laboratory for faecal examination.

Coprological examination

All collected faecal samples were processed using the simple flotation technique with NaCl solution (Zajac and Conboy, 2012). A qualitative and quantitative faecal examination was made to search for nematode eggs and to determine the level of infestation. The eggs of different nematodes were identified using keys given by Taylor et al. (2007). The faecal egg count (eggs/gramme) was considered as a quantitative indicator of infestation level, and it was determined by a modified McMaster technique, where 2 g of faeces was mixed in 28 ml of saturated NaCl solution with a lower detection limit of 50 eggs/g of faeces (Zajac and Conboy, 2012). The level of infestation was determined according to Upjohn et al. (2010) as none, mild (<500 egg per gram (EPG)), moderate (500–1000 EPG) and high (>1000 EPG).

Study variables

Prevalence of GIT nematodes and their level of infestations were dependent variables, whereas species, age, sex and body condition score were considered as independent variables, which could influence the level of infestation and prevalence of nematodes in equines.

Table 1 Coprological prevalence of major gastrointestinal nematodes identified in the equine species

Species	Strongyle type		*Parascaris equorum*		*Oxyuris equi*		Overall infestation rate	
	n (%)	95 % CI	*n* (%)	95 % CI	*n* (%)	95 % CI	*n* (%)	95 % CI
Horse (*n*=124)	86 (69.4)	61.3–77.5	11 (8.9)a	3.9–13.9	3 (2.4)	−0.3–5.1	91 (73.4)c	65.6–81.2
Donkey (*n*=200)	151 (75.5)	69.5–81.5	60 (30)b	23.7–36.4	12 (6)	2.7–9.3	173 (86.5)d	81.8–91.2
Mule (*n*=60)	45 (75)	64.0–86.0	11 (18.3)	8.3–28.0	2 (3.3)	−1.2–7.8	51 (85)	76.0–94.0
Overall (*n*=384)	282 (73.4)	69.0–78.0	82 (21.4)	17.3–25.5	17 (4.4)	2.4–6.5	315 (82)	78.2–85.8

Different letters in the same column indicate statistically significant differences ($P<0.05$); *n* number of animals, % prevalence in percentage

Data management and analysis

The raw data were managed and summarized using SPSS version 16. The association between considered factors and prevalence of nematode infestation was determined using a χ^2 test. Odds ratio (OR) and its 95 % confidence interval (95 % CI) were calculated to determine the degree of association between considered factors and the occurrence of GIT nematode infestation. A one-way ANOVA was also used to evaluate differences in faecal egg count among independent variables after log transformation of the values of EPG [using $\log(x+1)$] performed to minimize and stabilize the variance. All results were considered statistically significant when the *P* value <0.05 at 95 % confidence interval.

Results

Three hundred and fifteen (82 %) equids were demonstrated to harbour endoparasites in terms of shedding at least one type of nematode eggs. Out of these, 18.7 % were due to mixed infestation. The overall prevalence of GIT nematode infestation in horses, mules and donkeys was 73.4, 85 and 86.5 %, respectively. The identified nematodes were *Strongyle* type (73.4 %), *Parascaris equorum* (21.6 %) and *Oxyuris equi* (4.4 %) (Table 1).

The result showed that species of equines had a significant ($\chi^2=9.35$, $P<0.01$) association with the occurrence of GIT nematode infestation. Donkeys were two times (OR=2.3, 95 % CI 1.27–4.28, $P<0.01$) more likely to get GIT nematode infestations than horses. Moreover, donkeys were four times (OR=4.4, 95 % CI 2.16–9.7, $P<0.0001$) more likely of getting *P. equorum* than horses (Table 1).

In horses, GIT nematode infestation was significantly associated with sex ($\chi^2=4.5$, $P=0.034$) and body condition score ($\chi^2=11.76$, $P=0.003$), but not with the age of study horses ($P>0.05$). Female horses were approximately three times (OR=2.9, 95 % CI 1.1–8.6, $P=0.021$) more likely to be diagnosed with strongyle-type nematode than males. Similarly, poor body conditioned horses had approximately nine times (OR=8.5, 95 % CI 1.7–42.3, $P=0.009$) higher odds of being infested with strongyle-type nematodes than good scored horses. Although there was no significant ($\chi^2=1.55$, $P>0.05$) variation among age categories, the occurrence of strongyle-type nematode infestation increased with increasing horse age (Table 2). Younger horses were demonstrated to be five times (OR=5.39, 95 % CI: 1.23–26.8, $P<0.01$) more likely of harbouring *P. equorum* than adult horses.

As indicated in Table 3, in donkeys, GIT nematode infestation was significantly associated with age ($\chi^2=7.20$, $P=0.027$) and body condition score ($\chi^2=28.19$, $P<0.001$) of study animals. Strongyle-type nematodes were found to occur approximately two times (OR=2.17, 95 % CI 1.1–4.3, *P*=

Table 2 Overall prevalence of major gastrointestinal nematodes of horses vs risk factors

Risk factors		Strongyle type		*P. equorum*		Overall infestation rate	
		n (%)	95 % CI	*n* (%)	95 % CI	*n* (%)	95 % CI
Age	Young (*n*=32)	20 (62.5)	45.7–79.3	7 (21.9)a	7.6–36.2	23 (71.9)	56–88
	Adult (*n*=81)	57 (70.4)	60.5–80.3	4 (4.9)b	0.2–9.6	59 (72.8)	63–83
	Old (*n*=11)	9 (81.8)	59–104.6	–	–	9 (81.8)	59–105
Sex	Female (*n*=41)	34 (82.9)a	71.4–94.4	4 (9.8)	0.7–18.9	35 (85.4)c	74.6–96.2
	Male (*n*=83)	52 (62.7)b	52.5–73.3	7 (8.4)	2.4–14.4	56 (67.5)d	57.4–77.6
BC	Poor (*n*=19)	17 (89.5)a	75.7–103.3	2 (10.5)	−3.3–24.3	17 (89.5)c	75.7–103.3
	Medium (*n*=69)	51 (73.9)a	63.5–84.3	7 (10.1)	3–17.2	55 (79.7)c	70.2–89.2
	Good (*n*=36)	18 (50.0)b	33.7–66.3	2 (5.6)	−2–13.1	19 (52.8)d	36.5–69.1

Different letters in the same column indicate statistically significant differences ($P<0.05$) at each factor

Table 3 Overall prevalence of major gastrointestinal nematodes of donkeys vs risk factors

Risk factors		Strongyle type		*P. equorum*		Overall infestation rate	
		n (%)	95 % CI	*n* (%)	95 % CI	*n* (%)	95 % CI
Age	Young (*n*=70)	45 (64.3)a	53.1–75.5	38 (54.3)b	42.6–66	65 (92.9)d	86.9–98.9
	Adult (*n*=108)	86 (79.6)b	72–87.2	19 (17.6)c	10.4–24.8	87 (80.6)e	73.1–88.1
	Old (*n*=22)	20 (90.9)b	78.9–102.9	3 (13.6)c	−0.7–27.9	21 (95.5)	86.8–104.2
Sex	Female (*n*=78)	53 (67.9)	57.5–78.2	22 (28.2)	18.2–38.2	63 (80.8)	72.1–89.5
	Male (*n*=122)	98 (80.3)	73.2–87.4	38 (31.1)	22.9–39.3	110 (90.2)	84.9–95.5
BC	Poor (*n*=34)	33 (97.1)a	91.5–102.7	23 (67.6)b	51.9–83.3	34 (100)	100–100
	Medium (*n*=123)	92 (74.8)b	67.1–82.5	36 (29.3)c	21.3–37.3	112 (91.1)d	86.1–96.1
	Good (*n*=43)	26(60.5)b	45.9–75.1	1(2.3)d	−2.2–6.8	27(62.8)e	48.4–77.3

Different letters in the same column indicate statistically significant difference ($P<0.05$) at each factor

0.025) and six times (OR=5.56, 95 % CI 1.2–25.7, $P=0.028$) more in adult and old donkeys than in young animals, respectively. Similarly, *P. equorum* was diagnosed approximately six times (OR=5.56, 95 % CI 2.8–11, $P<0.001$) and eight times (OR=7.52, 95 % CI 2–27.8, $P=0.002$) more in young donkeys than in adult and older groups, respectively. Moreover, the demonstration of *P. equorum* was significantly ($\chi^2=16.7$, $P<0.0001$) higher in poor body conditioned donkeys than good scored donkeys. Likewise, it was five times (OR=5.05, 95 % CI 2.2–11.5, $P<0.0001$) more frequently diagnosed with poor body conditioned donkeys than medium scored animals.

In mules, the occurrence of GIT nematode infestation was not significantly ($P>0.05$) associated with considered factors. However, the occurrence of strongyle-type infestation was significantly ($\chi^2=4.98$, $P=0.026$) higher in old mules than younger groups. Significantly ($\chi^2=5.7$, $P=0.017$), higher *P. equorum* infestation was also recorded in young mules than adults. Moreover, mules which had a poor body condition score were diagnosed more frequently ($\chi^2=8.45$, $P=0.004$) with *P. equorum* than medium score mules (Table 4).

Level of infestation

The mean EPG for donkeys, mules and horses were 1831.2, 915.7 and 772.5, respectively (Table 5). Out of 315 infested equids, 89 (28.3 %) were affected mildly, 99 (31.4 %) moderately and 127 (40.3 %) highly (Fig. 1). The levels of infestation for donkeys, horses and mules are summarized in Fig. 1. Significantly higher ($P<0.05$) mean EPG was recorded in donkey and poor body condition score animals of each equine species. But age and sex were not shown to be significant risk factors on mean EPG of nematodes in each equine species.

Discussion

The overall prevalence of GIT nematode infestation in equines was higher than 80 %. This is consistent with previous reports in Ethiopia and elsewhere in the world (Getachew et al., 2010; Upjohn et al., 2010; Dessie and Melese 2013; Valdéz-Cruz et al., 2013; Yacob and Hagos, 2013). Similarly, Getachew et al. (2008) and Burden et al. (2010) also reported about

Table 4 Overall prevalence of major gastrointestinal nematodes of mules vs risk factors

Risk factors		Strongyle type		*P. equorum*		Overall infestation rate	
		n (%)	95 % CI	*n* (%)	95 % CI	*n* (%)	95 % CI
Age	Young (*N*=18)	10 (55.6)a	32.7–78.6	7 (38.9)c	16.9–61.4	16 (88.9)	74.4–103.4
	Adult (*N*=24)	19 (79.2)	63–95.4	2 (8.3)d	−2.7–19.3	19 (79.2)	63–95.4
	Old (*N*=18)	16 (88.9)b	74.4–103.4	2 (11.1)	−3.41–25.6	16 (88.9)	74.4–103.4
Sex	Female (*N*=9)	6 (66.7)	35.9–97.5	1 (11.1)	−9.4–31.6	7 (77.8)	58.6–97
	Male (*N*=51)	39 (76.5)	64.9–88.1	10 (19.6)	8.7–30.5	44 (86.3)	76.9–95.7
BC	Poor (*N*=10)	9 (90.0)	71.4–108.6	6 (60.0)c	29.6–90.4	10 (100)	100–100
	Medium (*N*=34)	24 (70.6)	55.3–85.9	5 (14.7)d	2.8–26.6	28 (82.4)	69.6–95.2
	Good (*N*=16)	12 (75.0)	51.5–98.5	–	–	13 (81.3)	62.3–100.4

Different letters in the same column in indicate statistically significant differences ($P<0.05$) at each factor

Table 5 Analysis of EPG variation vs considered factors

Risk factors	No. of infected animals	Mean of EPG	Standard error	95 % CI	*F*	*P* value
Species						
Horse	91	772.5a	78.6	616.3–928.8	23.3	<0.001
Donkey	173	1831.2b	123.2	1588–2074.5		
Mule	51	915.7a	110.6	693.6–1137.8		
Sex						
Female	105	1300.0	132.7	1036.8–1563.2	0.479	0.489
Male	210	1415.7	97.9	1222.8–1608.6		
Age						
Young	104	1243.3	125.6	994.2–1492.4	0.809	0.446
Adult	165	1420.6	115.4	1192.7–1648.5		
Old	46	1523.9	197.7	1125.7–1922.1		
Body condition						
Poor	61	2157.4c	185.5	1786.4–2528.3	12.7	<0.001
Medium	195	1194.4d	92.6	1011.8–1377		
Good	59	1174.6d	185.2	803.8–1545.3		

Different letters in the same column indicate statistically significant differences ($P<0.05$); *95% CI* 95 % confidence interval of mean EPG

90 % infestation rate in equids. Thus, using our and other reports, it can be concluded that the tropical environmental conditions of Ethiopia are favourable for GIT nematode transmission to equids.

In our observation, donkeys were diagnosed more frequently with GIT nematodes than horses. This agrees with the reports of Fikru et al. (2005) and Adam et al. (2013), who stated higher susceptibility of donkeys to nematodes than horses. This observed difference could be due to the fact that donkeys in Ethiopia are subjected to poor management and extensive workload with less deworming practices (Getachew et al., 2008), which could increase their susceptibility to the parasite infestation. Moreover, this was probably due to the relatively good trend of deworming in our study area, which has been becoming a routine activity of cart horse owners due to economic reasons and owners' awareness about their horses' welfare. In fact, these require emphasis and further investigation.

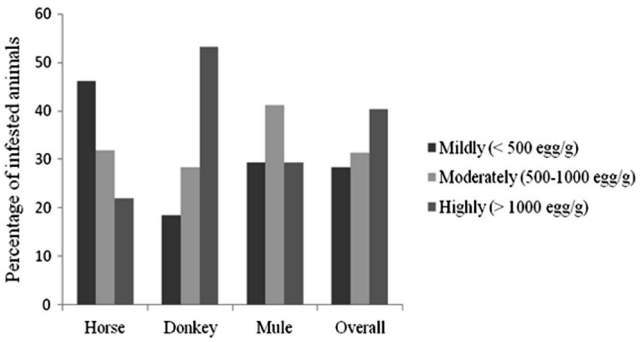

Fig. 1 Level of infestation based on the total egg count in infested equine in and around Shashemane, southern Ethiopia

A direct-age association of strongyle-type nematode infestation was observed in all equine species where was it frequently diagnosed in older followed by adult equines. This is in agreement with other reports (Getachew et al., 2008; Upjohn et al., 2010; Ferdowsi et al., 2011) in Ethiopia, Lesotho and Iran, respectively. However, our finding is inconsistent with the report in India by Yadav et al. (2014). This direct age association might be due to frequent contact with permanent grazing land, poor management, malnutrition and immunocompromise due to overwork stress. According to Getachew et al. (2008), equines vary in their reaction to parasite infestation with age, body condition and management type. This requires more attention and further studies to verify the role of age, body condition and management on equines' response to parasite infestation under tropical environment.

P. equorum occurrence was significantly higher in donkeys, younger and poor body conditioned equines. This agrees with AL-Anazi and Alyousif (2011) and Desie and Melese (2013) reports. This was not surprising because *P. equorum* is principally a parasite of young and poor body condition score equines (Taylor et al., 2007). This could be attributed to the development of acquired immunity with increasing of age and body condition score (Zajac and Conboy, 2012). Equines could develop an excellent acquired immunity against *P. Equorum*, which results in infestation being limited to suckling, weaning and yearlings and being observed occasionally in equines older than 2 years (Reinemeyer and Nielsen, 2009).

O. equi was a less frequently encountered nematode in all equine species. This is comparable with reports from Ethiopia (Getachew et al., 2010; Dessie and Melese, 2013) and elsewhere in the world (Upjohn et al., 2010; AL-Anazi and

Alyousif 2011). This might be related to the egg-laying behaviour of female worms, which deposit their eggs out of the rectum around the perineum, so their eggs are not often seen in faecal flotation tests (Zajac and Conboy, 2012). Though there was no significant variation, *O. equi* infestation rate in this study was found to be higher in donkeys and younger equines. This could be due to the fact that *O. equi* is the parasite of younger equines and stressed animals because of their weak immune status (Zajac and Conboy, 2012).

The mean EPG was significantly higher in donkeys and poor body conditioned animals in each equine species. This agrees with the report of Dessie and Melese (2013) in Ethiopia. This could be due to poor management, overwork stress and immunocompromised responses in donkeys and poor body condition score equines (Dessie and Melese, 2013). Similarly, Singh et al. (2002) explained the differences among species in susceptibility to nematodes that might be accounted by better management practices and inherent immune capability. Therefore, poor management and low plane of nutrition could reduce the immune status, which could create a favourable condition to heavy parasitic infestation (Valdéz-Cruz et al., 2012). Even though there was no significant variation, higher mean EPG was recorded in older than adult and young equids. This is inconsistent with the work of Asefa et al. (2011) and Dessie and Melese (2012) who documented higher mean EPG in younger than older equines in Ethiopia. This higher mean EPG in older equines in our report might be attributed to the compromised immune responses relating to aged animals.

In conclusion, GIT nematode infestation was found to be high in equids, with an overall prevalence of 82 %. The overall prevalence of nematode infestation was higher in donkeys followed by mules. Higher overall prevalence of strongyle-type nematode infestation was recorded in all equine species followed by *P. equorum* and *O. equi*. *P. equorum* and *O. equi* were found to be more prevalent and significant problems of young equines. The result also revealed that there were equines suffering from high levels of infestation with major gastrointestinal nematodes. Therefore, this information might help in designing strategies to control endoparasite infestations in equines in Ethiopia. More emphasis should be given to awareness creation on animal welfare and management with strategic deworming.

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Conflict of interest The authors declare that they have no competing interests.

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